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Weed management effect on weed growth and yield of foxtail millet [*Setaria italica* (L.) Beauv]

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ABSTRACT

A field experiment was conducted during (rainy season) *Kharif* 2020 at wetland farm of S.V. Agricultural College, Acharya N.G. Ranga Agricultural University, Tirupati, Andhra Pradesh, India to study the effect of different pre-emergence herbicides alone or in combination with inter-cultivation on weeds growth and yield of foxtail millet. The predominant weed flora associated with foxtail millet was *Digitaria sanguinalis* (L.) Scop. (42%), *Cyperus rotundus* L. (22%), *Cucumis callosus* (9%), *Boerhavia erecta* L. (6%), *Commelina benghalensis* L. (5%) and others (16%). The hand weeding (HW) twice at 20 and 40 days after seeding (DAS) resulted in lower density and biomass of all weeds with higher weed control efficiency, grain yield and benefit-cost ratio. Next best treatment was pre-emergence application of pretilachlor 500 g/ha or pyrazosulfuron-ethyl 15 g/ha followed by (*fb*) inter-cultivation at 20 DAS. The decrease in grain and straw yield due to weeds in unweeded check was 63.42 and 26.95% respectively, compared to HW twice.

Foxtail millet [*Setaria italica* (L.) Beauv] is grown as rainfed *Kharif* crop in India. Among agronomic practices, appropriate weed control is considered to be important aspect due to heavy losses caused by uncontrolled weeds (Munirathnam and Sawadhkar 2007). Weed flora associated with foxtail millet are highly diversified and vary depending upon the season, agroecological condition and level of management. The slow growing canopy of foxtail millet, during the initial growth, makes it susceptible to weed competition. Generally, small millets are relatively poor competitors for growth resources than weeds, especially during the early stages of the crop. Severe weed infestation is noticed in foxtail millet due to its slow growth at initial stages during rainy season. The initial period of 4-6 weeks after seedling emergence was considered as critical period for weed removal. Ning *et al.* (2015) stated that grain yield of foxtail millet was reduced by 56% due to presence of weeds throughout the crop season on calcareous soils. Pre-emergence herbicides improve the weed control and production efficiency in major millets due to their bigger seed size and comparatively deeper depth of sowing than small millets (Mishra 2016). The research findings on chemical weed management in foxtail millet are very meagre. In recent years, as the cost of hand weeding increased, farmers are inclined to use herbicides in small millet crops for effective control of weeds. Hence, the present study was undertaken to assess the efficacy of pre-emergence application (PE) of herbicide supplemented with inter-cultivation or post-emergence application (PoE) of penoxsulam for weed control with better selectivity in foxtail millet.

A field experiment was conducted during (rainy season) *Kharif* 2020 at wetland farm of S.V. Agricultural College, Acharya N.G. Ranga Agricultural University, Tirupati, Andhra Pradesh, India. The soil was sandy clay loam in texture, neutral in reaction, low in organic carbon and available nitrogen, medium in available phosphorus and available potassium. The experiment was laid out in a randomized block design with eleven treatments and replicated thrice. Foxtail millet was sown at a spacing of 30 x 10 cm on 14th August, 2020.The weed management treatments consisted of pre-emergence application (PE) of pretilachlor, isoproturon and pyrazosulfuron-ethyl 500, 500 and 15 g/ha, respectively; hand weeding

twice and un-weeded check (**Table 1**). All the pre-emergence herbicides were supplemented with inter-cultivation or post-emergence application (PoE) of penoxsulam 20 g/ha, at 20 days after seeding (DAS). Pre-emergence herbicides were applied at 1 DAS and inter-cultivation/post-emergence herbicide, penoxsulam was applied at 20 DAS. All the pre-and post-emergence herbicides were applied with the help of knapsack sprayer fitted with flat fan nozzle and spray volume of 500 L/ha. Uniform dose of 20 kg N and 20 kg P was applied in the form of urea and single super phosphate, respectively to all the plots. Nitrogen was applied in two splits, *viz*. half of the dose as basal and the remaining half of the dose as top dressing at 30 DAS and entire dose of phosphorous was applied as basal at the time of sowing itself. The rest of the packages of practices were adopted as per recommendations of the Acharya N.G. Ranga Agricultural University. Category wise weed density and biomass were recorded randomly with the help of 0.25 m^2 quadrat. The data on weed density and biomass were transformed to square root $\sqrt{X+0.5}$ transformation to normalize their distribution. Weed control efficiency was computed as per the method suggested by (Mani *et al*. 1973). All the yield components, *viz*. number of panicles/m^2, grain weight/panicle and 1000-grain weight were recorded at harvest. Benefit-cost ratio was calculated after dividing gross returns with cost of cultivation. The crop was harvested on 5th November, 2020. The weed and crop data were analysed statistically by following the analysis of variance for randomized block design as suggested by Panse and Sukhatme (1985).

Effect on weed density and biomass

The predominant weed flora associated with foxtail millet was *Digitaria sanguinalis* (L.) Scop. (42%), *Cyperus rotundus* L. (22%), *Cucumis callosus* (9%), *Boerhavia erecta* L. (6%), *Commelina benghalensis* L. (5 %), *Cynodon dactylon* (L.) Pers. (5%), *Borreria hispida* (L.) K. Schum. (3%), *Cleome viscosa* L. (3%) and others (5%). All the weed management treatments significantly influenced the weed growth and yield of rainfed foxtail millet (**Table 1**). Among the weed management practices tested, the lowest density and biomass of grasses, sedges, broad-leaved weeds and total weeds as well higher weed control efficiency were obtained with pretilachlor 500 g/ha PE *fb* inter-cultivation at 20 DAS which was comparable with pyrazosulfuron-ethyl 15 g/ha PE *fb* inter-cultivation at 20 DAS and

Table 1. Weed density and biomass and weed control efficiency as influenced by different weed management treatments at harvest in foxtail millet

Treatment	Weed density (no./m^2)				Weed biomass (g/m^2)				WCE (%)
	Grasses	Sedges	BLWs	Total	Grasses	Sedges	BLWs	Total	
Pretilachlor (PE) 500 g/ha at 1 DAS	5.98 (35.33)	8.67 (74.67)	4.70 (21.67)	11.49 (131.67)	7.32 (53.67)	4.90 (24.43)	4.09 (16.27)	10.06 (94.37)	27.34
Isoproturon (PE) 500 g/ha at 1 DAS	6.04 (36.00)	8.69 (75.00)	4.78 (22.33)	11.57 (133.33)	7.39 (54.17)	4.94 (24.57)	4.21 (17.23)	10.14 (95.93)	26.13
Pyrazosulfuron-ethyl (PE) 15 g/ha at 1 DAS	6.01 (35.67)	8.68 (74.83)	4.74 (22.00)	11.53 (132.50)	7.38 (54.13)	4.88 (24.53)	4.16 (16.87)	10.12 (95.60)	26.39
Pretilachlor (PE) 500 g/ha *fb* IC at 1 + 20 DAS	4.18 (17.00)	6.40 (40.30)	3.58 (12.33)	8.36 (69.33)	3.69 (13.17)	3.48 (11.67)	2.77 (7.23)	5.70 (32.07)	75.31
Isoproturon (PE) 500 g/ha *fb* IC at 1 + 20 DAS	4.26 (17.67)	6.50 (41.33)	3.67 (13.00)	8.51 (72.00)	4.11 (17.33)	3.51 (11.87)	2.84 (7.57)	6.07 (36.77)	71.69
Pyrazosulfuron-ethyl (PE) 15 g/ha *fb* IC at 1 + 20 DAS	4.22 (17.33)	6.36 (40.00)	3.63 (12.67)	8.44 (70.67)	4.07 (16.93)	3.46 (11.53)	2.78 (7.27)	6.01 (35.73)	72.48
Pretilachlor (PE) *fb* penoxsulam (PoE) 500 + 20 g/ha at 1 + 20 DAS	5.36 (28.20)	7.76 (59.67)	4.12 (16.47)	10.24 (104.33)	6.15 (37.40)	4.39 (18.73)	3.57 (12.27)	7.39 (68.40)	47.33
Isoproturon (PE) *fb* penoxsulam (PoE) 500 + 20 g/ha at 1 + 20 DAS	6.63 (44.00)	9.51 (90.00)	5.24 (27.00)	12.70 (161.00)	8.02 (64.33)	5.47 (30.60)	4.64 (21.00)	11.56 (117.27)	9.70
Pyrazosulfuron-ethyl (PE) *fb* penoxsulam (PoE) 15 + 20 g/ha at 20 DAS	5.37 (28.33)	7.88 (61.67)	4.12 (16.50)	10.34 (106.50)	6.18 (37.80)	4.42 (19.13)	3.63 (12.67)	7.45 (69.60)	46.41
Hand weeding twice 20 and 40 DAS	2.74 (7.00)	3.53 (12.00)	1.68 (2.33)	4.67 (21.33)	1.67 (2.30)	2.2 (4.67)	1.42 (1.53)	2.98 (8.50)	93.45
Unweeded check	7.31 (53.00)	10.37 (107.0)	5.73 (32.33)	13.89 (192.33)	8.46 (71.13)	6.07 (35.33)	5.12 (25.73)	13.20 (129.87)	-
LSD (p=0.05)	0.54	0.78	0.44	1.06	0.60	0.44	0.40	0.84	

Data given in parentheses are original values. Original data subjected to square root transformation. WCE: weed control efficiency; IC: Intercultivation *fb*: followed by; PE: Pre-emergence; PoE: Post-emergence

Table 2. Yield components and yield as influenced by different weed management treatments in foxtail millet

Treatment	No. of panicles/ m^2	Weight of the panicle (g)	Grain weight panicle (g)	1000-grain weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Benefit-cost ratio
Pretilachlor (PE) 500 g/ha at 1 DAS	47.00	4.82	3.09	3.23	1309	3008	1.86
Isoproturon (PE) 500 g/ha at 1 DAS	47.00	4.51	3.04	3.21	1182	2962	1.68
Pyrazosulfuron-ethyl (PE) 15 g/ha at 1 DAS	47.00	4.52	3.07	3.21	1284	2.978	1.85
Pretilachlor (PE) 500 g/ha *fb* IC at 1 + 20 DAS	62.67	6.20	4.01	3.27	1961	3592	2.37
Isoproturon (PE) 500 g/ha *fb* IC at 1 + 20 DAS	56.00	6.06	3.59	3.17	1660	3348	2.11
Pyrazosulfuron-ethyl (PE) 15 g/ha *fb* IC at 1 + 20 DAS	58.33	6.13	3.74	3.18	1745	3435	2.14
Pretilachlor (PE) *fb* penoxsulam (PoE) 500 + 20 g/ha at 1 + 20 DAS	37.33	3.63	1.29	2.68	779	2438	1.09
Isoproturon (PE) *fb* penoxsulam (PoE) 500 + 20 g/ha at 1 + 20 DAS	32.00	3.39	1.24	2.52	690	2250	1.02
Pyrazosulfuron-ethyl (PE) *fb* penoxsulam (PoE) 15 + 20 g/ha at 20 DAS	33.33	3.54	1.21	2.67	724	2397	1.06
Hand weeding twice 20 and 40 DAS	70.00	7.06	4.61	3.64	2353	3944	1.92
Unweeded check	38.67	3.72	2.33	2.71	0861	2881	1.35
LSD (p=0.05)	6.72	0.75	0.42	0.42	0315	0419	0.17

IC: Intercultivation *fb*: followed by; PE: Pre-emergence; PoE: Post-emergence

isoproturon 500 g/ha PE *fb* inter-cultivation at 20 DAS which might be due to broad-spectrum and season long weed control as reported by Munirathnam and Sawadhkar (2007). However, all these treatments were significantly less effective in reducing weed growth than HW twice at 20 and 40 DAS.

Different weed management treatments in foxtail millet caused variation in number of panicles/ m^2, weight of the grains / panicle, 1000-grain weight, grain and straw yield (**Table 2**). Significantly higher number of panicles/m^2, weight of the grains / panicle grain and straw yield were recorded with HW twice and it was closely followed by pre-emergence application of pretilachlor 500 g/ha *fb* inter-cultivation at 20 DAS due to reduced competition for growth resources, which in turn increased the translocation of photosynthates to developing grains. These results were in agreement with the findings of Yathisha *et al.* (2020) in direct-seeded finger millet. All the above weed management treatments were at par with each other with respect to test weight of foxtail millet. Sequential application of pre-emergence herbicides at recommended doses followed by application of penoxsulam at 20 DAS applied plots registered the lowest values of all the yield components and yield due to phytotoxicity effect of penoxsulam. The decrease in grain and straw yield due to heavy weed infestation in unweeded check was 63.42 and 26.95 per cent, respectively, compared to best weed management practice. Among all the weed management practices, the highest benefit-cost ratio was realized with pre-emergence application of pretilachlor 500 g/ha *fb* inter-cultivation at 20 DAS and it was closely followed by pre-emergence application of pyrazosulfuron-ethyl 15 g/ha *fb* inter-cultivation at 20 DAS. Hand weeding twice recorded lesser benefit-cost ratio than all treatments constituting the pre-emergence herbicides application supplemented with inter-cultivation at 20 DAS, due to increased cost of manual weeding. Thus, under labour scarce situations, pre-emergence application of pretilachlor 500 g/ha *or* pyrazosulfuron-ethyl 15 g/ha supplemented with inter-cultivation at 20 DAS may be used for broad-spectrum weed control and higher grain and straw yield as well as benefit-cost ratio in foxtail millet on sandy clay loam soils.

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